gests that the differences between mortality rates may not decrease with time.

We agree with Vincent that the initial resuscitation period is critical. However, it is inappropriate to conclude, in the absence of supporting evidence, that treatment in the next 24 hours is unlikely to make a difference. The large prior experience with this therapy must be considered. In a meta-analysis involving 1425 patients, 786 of 978 patients received more than 1 polymyxin B treatment.6

We acknowledge Dr Kida’s observation of the preponderance of gram-positive organisms in the polymyxin B group. It is unlikely that this is a significant confounder. More than one-third of all patients had multiple organisms. Patients with gram-positive isolates also had gram-negative organisms. We agree that, in the absence of endotoxin measurements, the observed effects cannot be directly attributed to endotoxin removal. However, this hypothesis is logical in this context and biologically plausible.

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Financial Disclosure: None reported.


RESEARCH LETTER

Estimate of the Carbon Footprint of the US Health Care Sector

To the Editor: Despite heightened worldwide interest in sustainable health care, the carbon footprint of the US health care sector has not yet been estimated. Quantifying the environmental impact of health care is important to determine the potential value of mitigation efforts and to reduce harm associated with health care delivery. We estimated the carbon footprint of the US health care sector, defined as total greenhouse gas (GHG) emissions attributable to the production of health care goods and services.

Methods. Health care GHG emissions were estimated using 2007 data on health expenditures published by the National Health Accounts Team1 and the Environmental Input-Output Life-Cycle Assessment (EIOLCA) model developed by the Carnegie Mellon University Green Design Institute.2 The EIOLCA is based on the 1997 Industry Benchmark Producer Price input-output table from the US Bureau of Economic Analysis and is a matrix showing the dollar amounts of commodities that industries purchase from each other to produce their own commodities. EIOLCA augments input-output tables with data on pollutants and emissions released as by-products of each commodity. Category-specific GHG/dollar coefficients that express the amount of carbon dioxide (measured in metric tons) embodied in each dollar of health care produced were obtained from the EIOLCA. Category-specific health spending was multiplied by its corresponding coefficient to obtain GHG totals and then summed across categories to estimate the health care sector carbon footprint.

Carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons were accounted for. Greenhouse gas emissions are expressed in terms of global warming potential (GWP): the mass of carbon dioxide producing an equivalent effect on the balance of incoming and outgoing radiant energy in the earth’s system over a century, measured in units of million metric tons of carbon dioxide equivalent (MMTCO2Eq).3 Direct effects of health care activities and indirect effects that include upstream supply-chain effects were calculated. A detailed methodological appendix is available from the authors on request.

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Results. The results are presented in the TABLE. The health care sector, including upstream supply-chain activities, contributed an estimated total of 546 MMTCO2Eq, of which 254 MMTCO2Eq (46%) was attributable to direct activities. The largest contributors were the hospital and prescription drug sectors (39% and 14%, respectively). Approximately 80% of total global warming potential was due to carbon dioxide emissions.

Comment. In 2007, the health care sector accounted for 16% of US gross domestic product; total effects of health care activities contributed 8% of total US GHG (7150 MMTCO2Eq) and 7% of total carbon dioxide emissions (6103 MMTCO2Eq). For comparison, the National Health Service accounted for 3% of total UK carbon dioxide in 2004 in a similar EIOlCA analysis.

Study limitations include the inability to account for uncertainty, which may be introduced in any cell of the EIOlCA matrix and propagate throughout the model. The high dimensionality of sector-wide models poses data and computational challenges in estimating uncertainty but should be addressed in future research. There was a lag between 1997 industry accounts data forming the basis for the EIOlCA model and the 2007 health expenditure figures that were used. Although the 1997 model is the most recent available, it does not reflect improvements in production processes since 1997 that may have affected environmental impact. This data limitation is difficult to surmount: detailed input-output tables are updated every 5 years, and updating environmental data and merging them with input-output data have been accomplished by the Green Design Institute and made publicly available.

Measuring and reducing the environmental impact of health care may be considered an extension of efforts to improve health care quality and efficiency and to reduce unintended consequences. These results suggest that key points along the health care supply chain should be iden-

### Table. EIOlCA Estimates of Greenhouse Gas Emissions From the US Health Care Sector Based on National Expenditures, 2007

<table>
<thead>
<tr>
<th>Health Spending Categorya</th>
<th>Expenditures, Millions of 1997 US Dollarsb</th>
<th>Carbon Dioxide, MMTCO2Eqc</th>
<th>Methane, MMTCO2Eqc</th>
<th>Nitrous Oxide, MMTCO2Eqc</th>
<th>Chlorofluorocarbons, MMTCO2Eqc</th>
<th>Global Warming Potential, MMTCO2Eqc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct effectsd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>536 305</td>
<td>80.47</td>
<td>7.69</td>
<td>1.41</td>
<td>10.11</td>
<td>99.68</td>
</tr>
<tr>
<td>Physician/dental services</td>
<td>441 980</td>
<td>28.49</td>
<td>2.12</td>
<td>0.27</td>
<td>1.97</td>
<td>32.85</td>
</tr>
<tr>
<td>Other professional</td>
<td>98 714</td>
<td>15.92</td>
<td>0.83</td>
<td>0.25</td>
<td>1.42</td>
<td>18.43</td>
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<tr>
<td>Home health care</td>
<td>45 430</td>
<td>3.58</td>
<td>0.16</td>
<td>0.05</td>
<td>0.33</td>
<td>4.10</td>
</tr>
<tr>
<td>Nursing home care</td>
<td>101 101</td>
<td>20.58</td>
<td>2.29</td>
<td>0.20</td>
<td>0.31</td>
<td>23.38</td>
</tr>
<tr>
<td>Prescription drugs</td>
<td>175 175</td>
<td>32.95</td>
<td>2.16</td>
<td>0.89</td>
<td>1.69</td>
<td>37.69</td>
</tr>
<tr>
<td>Nondurable and durable equipment</td>
<td>47 663</td>
<td>5.37</td>
<td>0.29</td>
<td>0.02</td>
<td>0.08</td>
<td>5.76</td>
</tr>
<tr>
<td>Administrative/insurance</td>
<td>119 889</td>
<td>1.33</td>
<td>0.29</td>
<td>0.01</td>
<td>0.00</td>
<td>1.63</td>
</tr>
<tr>
<td>Scientific research</td>
<td>32 648</td>
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<td>0.21</td>
<td>0.06</td>
<td>0.18</td>
<td>4.51</td>
</tr>
<tr>
<td>Structures/equipment</td>
<td>77 539</td>
<td>24.80</td>
<td>0.59</td>
<td>0.21</td>
<td>0.03</td>
<td>25.63</td>
</tr>
<tr>
<td>Total</td>
<td>1 676 444</td>
<td>217.52</td>
<td>16.63</td>
<td>3.37</td>
<td>16.13</td>
<td>253.65</td>
</tr>
<tr>
<td>Total effectsf</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>536 305</td>
<td>162.54</td>
<td>29.02</td>
<td>10.83</td>
<td>12.26</td>
<td>214.65</td>
</tr>
<tr>
<td>Physician/dental services</td>
<td>441 980</td>
<td>61.02</td>
<td>8.57</td>
<td>1.86</td>
<td>3.33</td>
<td>74.78</td>
</tr>
<tr>
<td>Other professional</td>
<td>98 714</td>
<td>30.61</td>
<td>3.79</td>
<td>1.04</td>
<td>1.92</td>
<td>37.36</td>
</tr>
<tr>
<td>Home health care</td>
<td>45 430</td>
<td>7.37</td>
<td>0.85</td>
<td>0.22</td>
<td>0.43</td>
<td>8.88</td>
</tr>
<tr>
<td>Nursing home care</td>
<td>101 101</td>
<td>34.32</td>
<td>6.90</td>
<td>3.00</td>
<td>0.60</td>
<td>44.82</td>
</tr>
<tr>
<td>Prescription drugs</td>
<td>175 175</td>
<td>64.56</td>
<td>8.11</td>
<td>3.14</td>
<td>2.79</td>
<td>78.60</td>
</tr>
<tr>
<td>Nondurable and durable equipment</td>
<td>47 663</td>
<td>16.31</td>
<td>2.49</td>
<td>1.38</td>
<td>0.48</td>
<td>20.66</td>
</tr>
<tr>
<td>Administrative/insurance</td>
<td>119 889</td>
<td>8.30</td>
<td>1.50</td>
<td>0.20</td>
<td>0.11</td>
<td>10.10</td>
</tr>
<tr>
<td>Scientific research</td>
<td>32 648</td>
<td>7.79</td>
<td>0.93</td>
<td>0.26</td>
<td>0.29</td>
<td>9.28</td>
</tr>
<tr>
<td>Structures/equipment</td>
<td>77 539</td>
<td>41.73</td>
<td>3.20</td>
<td>0.74</td>
<td>0.74</td>
<td>46.41</td>
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<td>434.55</td>
<td>66.37</td>
<td>22.68</td>
<td>22.94</td>
<td>545.54</td>
</tr>
</tbody>
</table>

Abbreviations: EIOlCA, Environmental Input-Output Life-Cycle Assessment; MMTCO2Eq, million metric tons of carbon dioxide equivalent.

aExpenditure data from the National Health Expenditure Accounts Team, deflated to 1997 real US dollars using the Consumer Price Index ($1.002007=$0.771997). Spending on government public health activities was excluded because a corresponding industrial sector in the 1997 Industry Benchmark EIOlCA model was not available. Numbers may not sum to totals due to rounding.

bHealth care expenditure categories and corresponding North American Industrial Classification System sectors are in the technical appendix, available on request from the authors.

cEmissions of greenhouse gases expressed in terms of global warming potentials, defined as the effect of 1-kg emission of a gas on the balance of incoming radiant energy absorbed by the earth system and outgoing radiant energy reflected back out into space, relative to 1 kg of carbon dioxide over a 100-year period. Emissions of greenhouse gases other than carbon dioxide are expressed in terms of the amount of carbon dioxide that would produce an equivalent radiative potential effect over a 100-year period.

dAccounting for emissions from purchases by the corresponding health care subsector alone.

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Critical revision of the manuscript for important intellectual content:

Acquisition of data: Chung, Meltzer.

Analysis and interpretation of data: Chung, Meltzer.

Drafting of the manuscript: Chung, Meltzer.

Critical revision of the manuscript for important intellectual content: Chung, Meltzer.

Study supervision: Meltzer.

Financial Disclosures: Dr Chung reported holding shares in Conring, General Electric, and Environmental Power Corporation. No other disclosures were reported.

Funding/Support: The authors received support from grant U18 HS016967-01 from the Hospital Medicine and Economics Center for Education and Research in Therapeutics (CERT) (D.O.M.) and a Midcareer Career Development Award (K24-AG31326) from the National Institute of Aging (D.O.M.).

Role of the Sponsor: The funding sources had no role in the design and conduct of the study; in the collection, analysis, and interpretation of the data; or in the preparation, review, or approval of the manuscript.

Additional Contributions: Paulina Jaramillo, PhD, and Christopher Weber, PhD (both from the Green Design Institute at Carnegie Mellon University), provided valuable comments and guidance.

Author Contributions: Dr Chung had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Chung, Meltzer.

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